AMENDMENTS TO THE DRAWINGS:

Please find accompanying this response a replacement sheet for Fig. 1. The drawing amendments effect the following changes:

Reference numeral 10 is added to the drawing to indicate and enumerate the stator of the molded motor.

REMARKS

Claims 1, 6,7, 9, 10, and 12 - 14 remain in the application. Claims 2- 5, 8, and 11 are cancelled without prejudice. Claims 1, 6, 7, 9, 10, and 12 - 14 are amended herein to more particularly point out and distinctly claim the subject matter which the applicants regard as the invention.

Amended claim 1 incorporates the limitations of previous claims 1, 3, 4, 5, 8, and 11, and the further limitations of the straight core having a plurality of pre-molded supports for mounting the wiring circuit board; the binding pins connecting the winding wound on each tee; and the wiring circuit board being mounted on a plurality of supports in the stator.

Previous claim 2 has been cancelled, without prejudice.

Claims 3, 4, 5, 8, and 11 are cancelled, without prejudice, the subject matter of those claims being incorporated in amended claim 1, as stated above,

The dependencies of claims 9 and 10 have been amended from previous claim 8, now cancelled, to claim 1.

The dependency of claim 13 has been amended from previous claim 11, now cancelled, to claim 1.

In the Office Action, previous claims 1, 3 - 6, 11, 12, and 14 were rejected under 35 U.S.C. 103 (a) as being obvious and unpatentable over Japanese Patent

Document JP 10136589 to Tanabe ("Tanabe"), in view of U.S. Patent 6,673,463 to Onishi et al. ("Onishi et al").

The Examiner has contended that Tanabe discloses a motor having all of the elements and features of the motor recited according to previous claim 1 of the present application, except for disclosing that the motor frame is molded by covering the stator with a molded resin.

The Examiner further contends, however, that Onishi et al discloses a motor having the motor frame molded by covering the stator with a molded resin to form a molded motor.

Based on the foregoing, and because the two references relate to the same art area, the Examiner has stated that the purpose of Onishi et al would have been recognized in the pertinent art of Tanabe by a person of ordinary skill in the relevant art at the time that the present invention was made, and that it would have been obvious to such a person to modify the motor of Tanabe by covering the stator with a molded resin, as disclosed by Onishi et al.

Regarding previous claim 3 of the present application, the Examiner has also stated that Onishi et al discloses a molded motor wherein the motor frame is molded around a longitudinal axis of the stator by covering the entire stator, excluding an inside diametrical portion thereof, with the molding resin.

Regarding previous claim 4 of the present application, the Examiner has stated that Onishi et al discloses a molded motor wherein the molding resin is an insulating resin, and that the molding resin can be a premix.

Regarding previous claim 5 of the present application, the Examiner ha sstated that Onishi et al discloses a molded motot wherein a wiring circuit board is embedded in the motor frame.

Regarding previous claim 6 of the present application, the Examiner has stated that Onishi et al discloses a molded motor wherein a wiring circuit board is embedded in the motor frame and the straight core of the motor has a plurality of supports as well as an insulating layer thereon, pre-molded on one side thereof, for mounting the wiring circuit board.

Regarding previous claim 11 of the present application, the Examiner has stated that Onishi et al discloses a molded motor which is a brushless DC motor.

Regarding previous claim 12 of the presnt application, the Examiner has stated that Tanabe discloses a motor having 12 tees.

Regarding previous claim 14 of the present application, the Examiner has stated that Onishi et al discloses a molded motor for use in one of th devices as recited according to the claim.

Applicants respectfully disagree with the Examiner's analysis and conclusions of obviousness of the claims of the present application over Tanabe in

view of Onishi et al. Therefore, Applicants traverse this rejection. The following remarks are made with regard to the claims pending in the present application after entry of this Amendment.

The molded motor according to the present invention, as recited according to amended claim 1 of the present application, present after entry of this Amendment, recites the use of a straight core having the winding of the wire therearound, with the wires wound on the respective tees being connected by binding pins, with the straight core then being bent into an arcuate or annular shape. This improves the working efficiency of the winding or connecting wire, which increases more than by winding or connecting the wire itself in an acruate or annular shape.

In contrast, Tanabe discloses a motor structure wherein the wire is wound on a belt-shaped straight core, but lacks the element of the binding pins and the feature of bending the straight core.

Onishi et al, similarly, does not discloses an apparatus having the elements and features as those of the present application, as recited according to amended claim 1.

The molded motor according to amended claim 1 of the present application, has the feature of winding or connecting the wiring with a straight core, such that a belt-shaped straight core is pre-molded to form an insulating layer, and the

covering for providing the binding pins is simultaneously formed. In this way, the binding pins are readily attached for connecting the wiring.

Another feature of the molded motor according to the present application is formation of the supports for mounting the wiring circuit board at the same time as pre-molding of the insulation layer on the band-shaped straight core occurs.

By so doing, certain advantages are obtained, such as being able to mold the stator and the wiring circuit board without the need for special members; the ability to secure the positional relationship between the stator and the wiring circuit board; and ease at which molding is performed.

Neither Tanebe nor Onishi et al discloses such structures or embedding the wire circuit board together with the motor frame, or mounting the wiring circuit board on the supports.

Moreover, Applicants respectfully submit that the mere occurrence of two references in the same field of art is insufficient in and of itself to draw a conclusion of obviousness based on either reference in view of the other. There is nothing in either of the two references that teaches, discloses, or suggests the existence of a problem or particular need in the art which disclosure in the other one of the other references would provide the solution to, so as to at least suggest to a person of ordinary skill in the art that there was some basis to combine the subject matter of the two references.

Accordingly, Applicants respectfully submit that there is nothing in Tanabe or Onishi et al from which a person of ordinary skill in the art would be lead to combine the disclosure of these two references and arrive at an invention identical to that as taught according to the present invention and claimed as recited according to the claims in the application after entry of this Amendment. The disclosure in Onishi et al of a thermoplastic polymeric structural material suitable for use in a molded motor is insufficient to conclude therefrom that any and all motors, particularly one having the particular features such as disclosed in Tanabe, are suitable candidates for being constructed as a molded motor. There is nothing in Tanabe that can be discerned from the English language Abstract thereof, that teaches, discloses, or suggests that a motor having a stator, with a plurality of tees, and made into a ring form from a linearly shaped preform, as disclosed in Tanabe, can be fabricated as a molded motor by coating the stator with a resin coating.

Therefore, it is respectfully submitted that the combination of Tanabe and Onishi et al in order to render obvious the embodiments of the apparatus of the present application, particularly as taught according to any of previous claims 1, 3 - 6, 11, 12, and 14, is made out of hindsight.

For the foregoing reasons, it is respectfully requested that the 35 U.S.C. 103 (a) based rejection of previous claims 1, 3 - 6, 11, 12, and 14 of the present application be withdrawn, and it is further respectfully submitted that such basis for

rejection is not applicable to any of the amended claims presently in the application after entry of this Amendment.

In the Office Action, previous claim 2 of the present application was rejecetd under 35 U.S.C. 103 (a) as being obvious and unpatentable over Tanabe, in view of Onishi et al, in further view of Japanese Patent document JP 10271715 to Kikuchi ("Kikuchi").

The Examiner has stated that Tanabe and Onishi et al disclose all of the limitations of the apparatus of the present application, as recited according to previous claim 2, except for a molded motor wherein the joined ends of each back yoke are shaped like a crank.

The Examiner states, however, that Kikuchi discloses a motor having such a feature to prevent burnout of the stator coil by a laser beam.

Because the three references all relate to the same art area, the Examiner has contended that the purpose disclosed in Kikuchi would have been recognized in the pertinent art of Tanabe and Onishi et al by a person of ordinary skill in the art to which the present invention relates at the time the present invention as made, and that it would have been obvious to such a person to further modify a motor according to Tanabe, modified according to Onishi et al, by making the joined ends of each back yoke with a crank-like shape as taught by Kikuchi, for the purpose of preventing the stator coil from being burned out by a laser beam.

Applicants respectfully disagree with the basis for the Examiner's combination of the three references, the analysis of the Kikuchi et al reference, further to the previous analyses of the Tanabe and Onishi et al references, and the conclusion of obviousness drawn therefrom. Accordingly, Applicants traverse this rejection.

Applicants respectfully submit that Kikuchi et al does not teach, disclose, or suggest that the feature of making the joined surface at both ends of a back yoke of a stator core in a crank shape, and providing projections thereon, as disclosed according to the English language abstract of Kikuchi et al, is applicable to a molded motor as taught according to the present application.

Moreover, Applicants respectfully submit that the mere occurrence of the aforesaid three references in the same field of art is insufficient in and of itself to draw a conclusion of obviousness based on any of the reference in view of the other. There is noting in any of the references, individually, that teaches, discloses, or suggests the existence of a problem or particular need in the art which disclosure in any of the other references would provide the solution to, so as to at least suggest to a person of ordinary skill in the art that there was some basis to combine the subject matter of any of the references.

Therefore, it is respectfully submitted that the combination of Kikuchi et al with Tanabe and Onishi et al in order to render obvious the embodiment of the

apparatus of the present application, particularly as taught according to previous claim 2, is made out of hindsight; and that, moreover, even when such a combination is thus made, the resulting apparatus is different from that as taught according to the present application.

For the foregoing reasons, it is respectfully requested that the 35 U.S.C. 103 (a) based rejection of previous claim 2 of the present application be withdrawn, and it is further respectfully submitted that such basis for rejection is not applicable to any of the amended claims presently in the application after entry of this Amendment.

In any case, the obviousness rejection of previous claim 2 of the present application is rendered moot by the cancellation in the present Amendment, of previous claim 2.

In the Office Action, previous claim 7 of the present application was rejected under 35 U.S.C. 103 (a) as being obvious and unpatentable over Tanabe in view of Onishi et al, in further view of U.S. Patent 5,590,310 to Takano ("Takano").

The Examiner has stated that Tanabe and Onishi et al together disclose a motor having all of the elements and features of the apparatus of the present application according to previous claim 7, except for positioning projections

protruding from the supports for positioning the wiring circuit board held therebetween.

The Examiner further contends, however, that Takano discloses a motor having such a feature for the purpose of improving winding efficiency.

The Examiner states that because the three references all pertain to the same field of art, it would have been obvious to a person of ordinary skill in the relevant art to which the present invention pertains, at the time the present invention was made, to recognize that the purpose disclosed in Takano was pertinent to the art of Tanabe and Onishi et al, and that accordingly, such person would have further modified a motor according to Tanabe, already modified according to Onishi et al, by forming positioning projections protruding from the supports for positioning the wiring circuit board held therebetween, as taught by Takano, for the purpose of improving winding efficiency.

Applicants respectfully disagree with the basis for the Examiner's combination of the three references, the analysis of the Takano reference, further to the previous analyses of the Tanabe and Onishi et al references, and the conclusion of obviousness drawn therefrom. Accordingly, Applicants traverse this rejection.

Takano discloses a motor structure wherein the binding pins stand up relative to the stator, however, that reference does not discloses a structure wherein the binding pins stand up from the pre-molded covering, nor does it disclose a

structure wherein the wiring is connected on the binding pins and there is a band-shaped straight core.

Moreover, Applicants respectfully submit that the mere occurrence of the aforesaid three references in the same field of art is insufficient in and of itself to draw a conclusion of obviousness based on any of the reference in view of the other. There is noting in any of the references, individually, that teaches, discloses, or suggests the existence of a problem or particular need in the art which disclosure in any of the other references would provide the solution to, so as to at least suggest to a person of ordinary skill in the art that there was some basis to combine the subject matter of any of the references.

Therefore, it is respectfully submitted that the combination of Takano with Tanabe and Onishi et al in order to render obvious the embodiment of the apparatus of the present application, particularly as taught according to amended claim 7, is made out of hindsight; and that, moreover, even when such a combination is thus made, the resulting apparatus is different from that as taught according to the present application.

Moreover, nothing in Takano teaches, discloses, or suggests utilizing a stator coil structure, as there disclosed, particularly an embodiment as shown in Figs 2 and 16 of the reference, as a molded motor, by providing an insulating resin material over the stator.

For the foregoing reasons, it is respectfully requested that the 35 U.S.C. 103 (a) based rejection of previous claim 7 of the present application be withdrawn, and it is further respectfully submitted that such basis for rejection is not applicable to any of the amended claims presently in the application after entry of this Amendment.

In the Office Action, previous claim s 8 - 10 were rejected under 35 U.S.C. 103 (a) as being unpatentable over Tanabe in view of Onishi et al, and further in view of U.S. Patent 6,166,468 to Suzuki et al ("Suzuki et al").

Regarding previous claim 8, the Examiner contends that Tanabe and Onishi et al together discloses all of the elements and features of the apparatus of the present application, as recited according to previous claim 8, except a molded motor wherein a plurality of binding pins project from the covering for wiring the winding.

The Examiner contends, however, that Suzuki et al discloses a motor having such binding pins for connecting the stator coils to the printed circuit board.

The Examiner further contends that because the three references all relate to the same field of art, it would have been obvious to a person of ordinary skill in the art to which the present invention pertains, at the time the present invention was made, to recognize that the purpose disclosed by Suzuki et al was pertinent to the art of Tanabe and Onishi et al , and to further modify a motor according to Tanabe

et al, already modified according to Onishi et al, by forming a plurality of binding pins projecting from the covering for wiring the winding, as taught by Suzuki et al, for the purpose of connecting the stator coils to the printed circuit board.

Regarding previous claims 9 and 10 of the present application, the Examiner has stated that Suzuki et al discloses three binding pins and a neutral binding pin located on the outer periphery of the tees; and that it would have been obvious to a person of ordinary skill in the art to which the present invention pertains, at the time the present invention was made, to locate the binding pins at the location and in the manner recited according to previous claims 9 and 10, because it has been held that mere rearrangement of the parts of an invention involves only routine skill in the art.

The Examiner has stated that the terminals (40), disclosed in Suzuki et al at col. 4, lines 21 - 24, correspond to the binding pins taught in the present application, particularly as in amended claims 1, 9 and 10.

Applicants respectfully disagree with the basis for the Examiner's combination of the three references, the analysis of the Suzuki et al reference, further to the previous analyses of the Tanabe and Onishi et al references, and the conclusion of obviousness drawn therefrom. Accordingly, Applicants traverse this rejection.

Applicants respectfully submit that the terminals (40) disclosed in Suzuki et al are completely different from the structure and function of the binding pins according to the molded motor of the present application. The terminals (40) of the Suzuki et al apparatus are not formed on the tees of the straight core as are the three binding pins (17) and the neutral point binding pin (18) of the present apparatus.

In Suzuki, the terminals or connecting pins (40) are for electrically connecting the wiring and the wiring circuit board, and are not for use in supporting the wiring circuit board on the stator, as in the molded motor according to the present application.

In any case, nothing in Suzuki et al teaches, discloses, or suggests that the rotary electric machine, or motor, according to that reference is utilizable as a molded motor having a molded insulating resin covering a stator of the motor.

Moreover, Applicants respectfully submit that the mere occurrence of the aforesaid three references in the same field of art is insufficient in and of itself to draw a conclusion of obviousness based on any of the reference in view of the other. There is noting in any of the references, individually, that teaches, discloses, or suggests the existence of a problem or particular need in the art which disclosure in any of the other references would provide the solution to, so as to at least

suggest to a person of ordinary skill in the art that there was some basis to combine the subject matter of any of the references.

Therefore, it is respectfully submitted that the combination of Suzuki et al with Tanabe and Onishi et al in order to render obvious the embodiment of the apparatus of the present application, particularly as taught according to amended claims 1, 9, and 10, is made out of hindsight; and that, moreover, even when such a combination is thus made, the resulting apparatus is different from that as taught according to the present application.

For the foregoing reasons, it is respectfully requested that the 35 U.S.C. 103 (a) based rejection of previous claims 8 - 10 of the present application be withdrawn, and it is further respectfully submitted that such basis for rejection is not applicable to any of the amended claims presently in the application after entry of this Amendment.

In the Office Action, previous claim 13 of the present application was rejected under 35 U.S.C. 103 (a) as being obvious and unpatentable over Tanabe, in view of Onishi et al, and further in view of U.S. Patent 4,752,707 to Morrill.

Regarding previous claim 13, the Examiner has stated that Tanabe and Onishi et al together disclose a motor having all of the elements and features of the apparatus according to previous claim 13 of the present application, except for disclosing that the molded motor is a three-phase, brushless DC motor, having 12

tees, a U-phase winding wound around the first, fourth, seventh, and tenth tees from the tee at either end of the straight core; a V-phase winding around the second, fifth, eighth, and eleventh tees; and a W-phase winding around the third, sixth, ninth and twelfth tees.

The Examiner contends, however, that Morrill discloses a motor having the aforesaid features, for the purpose of forming a three-phase stator. The Examiner further contends that because the three references all relate to the same field of art, it would have been obvious to a person or ordinary skill in the art to which the present invention pertains, at the time the present invention was made, that the purpose disclosed in Morrill would have been recognized as pertinent to the art of Tanabe and Onishi et al, and to further modify a motor according to Tanabe, modified according to Onishi et al, by making a stator with 12 tees, and to provide U-, V-, and W-phase windings at the respectively indicated tees, in order to form a three phase stator.

Applicants respectfully disagree with the basis for the Examiner's combination of the three references, the analysis of the Morrill reference, further to the previous analyses of the Tanabe and Onishi et al references, and the conclusion of obviousness drawn therefrom. Accordingly, Applicants traverse this rejection.

Morrill relates to a three-phase, one-third pitch motor. Fig. 6 of the reference discloses a stator (62) with 12 teeth (63) (tees), with windings around the first, fourth, seventh, and tenth tees; around the second, fifth, eighth, and eleventh tees; and around the third, sixth, ninth, and twelfth tees.

Nothing in Morrill teaches, discloses, or suggests utilizing a motor, as there disclosed, particularly an embodiment as shown in Fig. 6 of the reference, as a molded motor, by providing an insulating resin material over the stator.

Moreover, Applicants respectfully submit that the mere occurrence of the aforesaid three references in the same field of art is insufficient in and of itself to draw a conclusion of obviousness based on any of the reference in view of the other. There is noting in any of the references, individually, that teaches, discloses, or suggests the existence of a problem or particular need in the art which disclosure in any of the other references would provide the solution to, so as to at least suggest to a person of ordinary skill in the art that there was some basis to combine the subject matter of any of the references.

It is respectfully submitted that the Examiner's combination of Morrill with the disclosures in Tanabe and Onishi et al in order to render obvious the embodiment of the apparatus of the present application, particularly as taught according to currently amended claim 13 presented by this Amendment, is made out of hindsight; and that, moreover, even when such a combination is thus made,

the resulting apparatus is different from that as taught according to the present application.

For the foregoing reasons, it is respectfully requested that the 35 U.S.C. 103 (a) based rejection of previous claim 13 of the present application be withdrawn, and it is further respectfully submitted that such basis for rejection is not applicable to any of the amended claims presently in the application after entry of this Amendment.

It is respectfully pointed out that there is nothing in any of the cited references themselves that teaches, discloses, or suggests a molded motor having all of the elements and features as that of the present application, particularly as recited according to the amended claims in the present application after entry of this Amendment, and especially as to amended claim 1. Applicants respectfully submit that any attempt to argue that a combination of the multiple references of among those cited above that could even conceivably lead to a molded motor having all of the claimed elements and features is one that is impermissibly based on hindsight. Applicants respectfully submit that if such a combination would have been obvious to a person of ordinary skill in the art to which the present invention relates, at the time the present invention was made, a molded motor having such elements and features would have previously been disclosed and/or commercialized. Applicants

respectfully submit that the absence of same is evidence of the non-obviousness of the molded motor according to the present application over any of the prior art.

In view thereof, reconsideration and further examination of the present application is respectfully requested after entry of the present Amendment.

Accordingly, it is respectfully submitted that the present application, containing the claims in the application, as entered by this Amendment, including claims 1, 6,7, 9, 10, and 12 - 14, are now in condition-for allowance, the early notification of which is earnestly solicited.

No additional claims fees are due with the filing of this Amendment.

This Amendment is being filed within the original three month shortened statutory period for response. Therefore, a Request for an extension of the time to respond is not required, and no fee for an extension of the time to respond is presently due.

No other fees are believed due with the filing of this Amendment. If, however, any other fees are due, or if Applicants are entitled to a refund of any previously made overpayments of fees, they should be respectively charged and credited to Deposit Account No. 12- 1250.

Respectfully submitted,

By _____
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Enc. - Substitute Spec; Marked Spec; Replacement Drawing Fig. 1

DESCRIPTION

MOLDED MOTOR

FIELD OF THE INVENTION

This invention relates to a molded motor.

BACKGROUND OF THE INVENTION

A stator for a molded motor is made by a common method in which an annular stator core is used, or a method in which a linear stator core (usually called a straight core) is bent into an annular shape. The prior art involving a straight core is disclosed in Japanese Patent Publications JP-A-9-308143, JP-A-10-136589 and JP-A-10-271715.

As a matter of fact, however, the manufacture of a molded motor using a straight core is difficult to carry out only with the art mentioned above.

This invention, therefore, provides an invention which ensures the manufacture of a molded motor using a straight core.

DISCLOSURE OF THE INVENTION

~~The invention according to claim 1~~ According to a first embodiment, the

apparatus of the present invention is a molded motor having a motor frame molded by covering a stator composed by a straight core with a molding resin, the straight core comprising a stack of laminas each having a plurality of tees projecting from one long side of a belt-shaped back yoke and a V-shaped cut formed between every two adjoining tees along the back yoke and on its side from which the tees project, the straight core having an insulating layer formed by pre-molding from an insulating resin on its portions excluding at least the inner periphery of each tee, the straight core further having a winding wound about each tee having the insulating layer formed thereon, the stator being formed by bending the straight core at the cuts into an arcuate or annular shape, and joining the opposite ends of the back yokes to each other by welding or adhesion.

~~The invention according to claim 2~~ According to a second embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 1~~ the first embodiment, in which the joined ends of each back yoke are shaped like a crank.

~~The invention according to claim 3~~ According to a third embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 1~~ the first embodiment, in which the motor frame is molded ~~about~~ around the longitudinal axis of the stator by covering [[the]] an entire outline of the stator, excluding [[its]] an inside diametrical portion thereof, with the molding resin.

~~The invention according to claim 4~~ According to a fourth embodiment, the

apparatus of the present invention is a molded motor as set forth in ~~claim 1~~ the first embodiment, in which the molding resin is an insulating resin, or premix.

~~The invention according to claim 5~~ According to a fifth embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 1~~ the first embodiment, in which a wiring circuit board is embedded in the motor frame.

~~The invention according to claim 6~~ According to a sixth embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 1~~ the first embodiment, in which a wiring circuit board is embedded in the motor frame and the straight core has a plurality of supports, as well as the insulating layer, pre-molded on one side thereof for mounting the wiring circuit board.

~~The invention according to claim 7~~ According to a seventh embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 6~~ the sixth embodiment, in which positioning projections for positioning the wiring circuit board protrude from the supports ~~for positioning~~ and the wiring circuit board is held therebetween.

~~The invention according to claim 8~~ According to an eighth embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 1~~ the first embodiment, in which the straight core has a covering, as well as the insulating layer, pre-molded on one side thereof, and a plurality of binding pins projecting from the covering for wiring the winding.

~~The invention according to claim 9~~ According to a ninth embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 8~~ the eighth embodiment, in which the binding pins are formed on the outer periphery of the first to third tees from the tee at either end of the straight core.

~~The invention according to claim 10~~ According to a tenth embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 8~~ the eighth embodiment, in which the binding pins include a neutral point binding pin formed on the back yoke situated on the outer periphery of one of the first to third tees from the tee at one end of the straight core, ~~while~~ and the binding pin for each phase is formed on the back yoke situated on the outer periphery of one of the first to third tees from the tee at the other end of the straight core, or on a plurality of such tees.

~~The invention according to claim 11~~ According to an eleventh embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 1~~ the first embodiment, ~~in which it~~ and is a brushless DC motor.

~~The invention according to claim 12~~ According to a twelfth embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 1~~ the first embodiment, in which ~~the number of the~~ there are 12 tees ~~is 12~~.

~~The invention according to claim 13~~ According to a thirteenth embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 11~~ the

eleventh embodiment, in which the brushless DC motor is [[a]] three-phase [[one,]]; [[the number of the]] there are 12 tees [[is 12, and]] ; there is a U-phase winding ~~is wound about~~ around the first, fourth, seventh and tenth tees from the tee at either end of the straight core[[,]]; there is a V-phase winding ~~about~~ around the second, fifth, eighth and eleventh tees; and there is a W-phase winding about the third, sixth, ninth and twelfth tees.

~~The invention according to claim 14~~ According to a fourteenth embodiment, the apparatus of the present invention is a molded motor as set forth in ~~claim 1~~ the first embodiment, ~~in which it is a motor~~ for use in an air conditioner, pump, washing machine, or air cleaner.

~~The invention according to claim 1 ensures the manufacture of~~ The apparatus according to the first embodiment of the present invention is a molded motor ~~using~~ manufactured from a straight core.

~~The invention according to claim 2~~ The apparatus according to the second embodiment of the present invention makes it possible to reduce any winding defect caused by welding and improve the flow of a magnetic flux across the joined ends of the back yoke. When the joined ends of the back yoke are welded together from its outer periphery by using e.g. a laser, there is no ~~fear~~ concern that any coil on the inner periphery of the back yoke may burn out, even if there may be a gap

between its joined ends, since a laser beam strikes against the crank-shaped bent surface therebetween. Moreover, it is possible to suppress the resonance of the joined ends of the back yoke which may be caused by a diametrically occurring electromagnetic vibration, in addition to preventing coil burnout during welding. Moreover, it is possible to secure a magnetic path.

~~The invention according to claim 3~~ The apparatus of the third embodiment of the present invention eliminates the necessity for a motor frame, since the molding resin forms a motor frame, and thereby eliminates the necessity for one bracket. The elimination of the necessity for one bracket makes it possible to shorten the distance between the winding and the bracket and thereby reduce the thickness of the motor.

The resin molding based on the inside diameter makes it possible to achieve coincidence between the inside diameter of the stator core and the longitudinal axes of the housing and socket portion and thereby improve the characteristics of the motor.

The motor frame formed from the resin enables the motor to have a long life without ~~being deteriorated~~ deteriorating, even if it ~~may be~~ is used in a highly humid environment, since the winding is covered with the insulating resin.

The resin covering the stator and forming the bracket makes it possible to reduce the thickness of the motor.

The resin covering the coils protects them from rubbing against each other irrespective of the vibration of the motor and makes them strong against wear and vibration-proof.

The winding covered with the insulating resin and the elimination of the necessity for one bracket make it possible to shorten the distance between the winding and the bracket and thereby reduce the thickness of the motor.

~~The invention according to claim 5~~ The apparatus of the fifth embodiment of the present invention provides a compact motor as the control board is embedded therein.

~~The invention according to claim 12 or 13~~ The apparatus of the twelfth and thirteenth embodiments of the present invention provides a structure which comparatively facilitates the work ~~for the~~ of installation of the winding, ~~etc.~~ and other elements ~~and~~ gives a motor of good performance.

~~The invention according to claim 14~~ The apparatus of the fourteenth embodiment of the present invention withstands a long period of use without ~~getting rusty~~ rusting, even when operating in a highly humid place.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a motor according to a first embodiment of the invention;

Fig. 2 is a top plan view of a punched sheet;

Fig. 3 is a front ~~elevational~~ elevation view illustrating a winding pattern for a stator core;

Fig. 4 is a perspective view of a straight core as viewed from its inner periphery;

Fig. 5 is a perspective view of the straight core as viewed from its outer periphery;

Fig. 6 is a front ~~elevational~~ elevation view illustrating a process for bending a straight core;

Fig. 7 is a front ~~elevational~~ elevation view of a stator made by bending the straight core into an annular shape;

Fig. 8 is a top plan view showing a wiring circuit board mounted on the stator;

Fig. 9 is an enlarged front ~~elevational~~ elevation view of a back yoke portion including its joined ends according to a second embodiment of the invention; and

Fig. 10 is an enlarged front ~~elevational~~ elevation view of a back yoke portion including its joined ends having a gap formed therebetween.

DETAILED DESCRIPTION OF THE INVENTION

Description will now be made of the best modes of carrying out this

invention starting with a first embodiment thereof. A three-phase brushless DC motor 50 according to the first embodiment of the invention and a process for manufacturing it will first be described with reference to Figs. 1 to 8.

1. Construction of the Motor 50

The construction of the motor 50 will be described with reference to Fig. 1. Fig. 1 is a sectional view of the motor 50.

The motor 50 ~~comprises~~ includes a motor frame 53, a rotor 56, a bracket 54 and two bearings 55. The motor frame 53, formed from an insulating molding resin 52, has a stator 10 and a wiring circuit board 51 embedded therein. The rotor 56 ~~comprises~~ includes a rotary shaft 57, a permanent magnet 60 and a yoke 58. The rotor 56 is held in the socket portion 59 of the motor frame 53 and the bracket 54, rotatably by a bearing 55. The bracket 54 is press fitted in the socket portion 59 of the motor frame 53.

The motor 50, constructed as described, is suitable as a motor used in a highly humid environment, since a stator core 7, a winding 8 and the wiring circuit board 51, having a control circuit, are covered with the insulating molding resin 52, and there is no ~~fear~~ concern of any water reaching the stator core 7 or the winding 8. The molding resin 52 is an insulating resin, or premix.

The molding resin 52, covering the winding 8 and the wiring circuit board 51, makes a vibration-proof motor.

The molding resin 52_1 covering the winding 8_1 permits a reduction in the distance between a charging portion and the bracket 54_1 made of a steel sheet. The elimination of one bracket ~~makes~~ permits construction of a motor having a small thickness along the rotary shaft.

The embedded wiring circuit board 51 makes a compact motor.

Thus, the motor 50 is most suitable as a source of a driving force for rotating a fan or impeller in an air conditioner, pump, washing machine, air cleaner, or the like.

(2) Process for Manufacturing the Motor 50

A process for manufacturing the motor 50 will now be described with reference to Figs. 2 to 4.

(2-1) Steps for Preparing the Stator Core 7

The stator core 7 is formed by stacking laminas 1_1 formed by punching a thin belt-shaped steel sheet (hereinafter called a hoop) 5, as shown in Fig. 2.

A plurality of (for example, eight) laminas 1 may be formed in parallel to one another across the width of the belt-shaped hoop 5, as shown in Fig. 2.

Each lamina 1 is formed by a belt-shaped back yoke 2 and 12 tees 3 extending from one long side 2a of the back yoke 2 at right angles thereto.

A V-shaped cut 4 is formed midway between every two adjoining tees 3 and on the long side 2a of the back yoke 2 from which the tees 3 extend.

Each tee 3 is T-shaped and is composed of a tee body 3a on which the wiring 8 is wound, and a horn-shaped converging portion 3b for causing magnetism to converge.

The punching steps will now be described.

During the first step, a belt-shaped hoop 5 is unwound from a coil.

During the second step, stop portions 21 are formed at specific intervals in the unwound hoop 5.

During the third step, the hoop 5 is transferred onto the punching table of a punching device.

During the fourth step, laminas 1 as described above, are cut out by a punch and allowed to drop into the receiving hole made in the punching table. One dropping lamina 1 is stacked on another immediately preceding lamina 1 and the laminas 1 as stacked are secured to each other at the stop portions 21 when pressed by the punch. The laminas 1 are stacked one upon another as described.

These manufacturing steps permit a continuous punching operation, as the hoop 5 is belt-shaped.

A plurality of laminas 1 can be stacked at one time, since a plurality of laminas 1 are formed in parallel to one another across the width of the belt-shaped hoop 5.

(2-2) Steps for Preparing Insulating Layers 12

The steps for preparing insulating layers 12 will now be described.

The insulating layers 12 are formed where they are required on the laminas 1 stacked as described above. This is due to the necessity for electrical insulation ~~made~~ between the stator core 7 and the winding 8. The insulating layers 12 are formed by pre-molding from an insulating resin on the stacked laminas 1, held in a resin mold.

The insulating layers 12 are formed on the portions, excluding the outer periphery, of the back yokes 2 and the inner periphery of the tees 3, as shown in Fig. 3. ~~In other words, they~~ They are formed on the long side portions 2a of the back yokes 2, both sides of the tee bodies 3a, and the outer peripheral surfaces of the converging portions 3b.

Upper coverings 14, four upper supports 15, and positioning projections 19 are formed at the top of the back yokes 2 integrally therewith at the same time with the insulating layers 12, as shown in Figs. 4 and 5. Lower coverings 20 are also formed at the bottom of the back yokes 2, integrally therewith, at the same time with the insulating layers 12.

The upper coverings 14 have securing holes formed for securing binding pins 17 and 18, as will be described below. The four upper supports 15 protrude from the upper coverings 14 and define a table for mounting the wiring circuit board 51, and the positioning projections 19 protrude integrally from the upper

supports 15. The upper supports 15 are formed on the fourth, sixth, tenth and twelfth tees 3 from the left end of the straight core 16, as shown in Fig. 4. A stack of laminas 1, having the insulating layers 12 formed thereon, is ~~called~~ referred to as straight core 16.

Although the upper coverings 14 and the upper supports 15 have been described as being formed at the top of the back yokes 2 and the lower coverings 20 at the bottom thereof, the terms upper and lower have been used for ~~the~~ convenience of ~~easy~~ description with reference to Figs. 4 and 5.

(2-3) Steps for Securing Binding Pins 17 and 18

The steps for securing the binding pins 17 and 18 will now be described with reference to Figs. 4 and 5.

Three phase binding pins 17, each for one phase, are first inserted in the securing hole of an upper covering 14 on or near the outer periphery of the back yokes 2 in the straight core 16 and caused to protrude from the straight core 16, as shown in Fig. 4. More specifically, the three phase binding pins 17 are caused to protrude from the outer periphery of one of the first, second and third tees 3 from the right end of the straight core 16. It is alternatively possible to cause the U-phase, V-phase and W-phase binding pins 17 to protrude from the first, second and third tees, respectively, from the right end of the straight core 16.

Then, a neutral point binding pin 18 is inserted in the securing hole of

another upper covering 14 on or near the outer periphery of the back yokes 2 in the straight core 16 and is caused to protrude from the straight core 16, as shown in Figs. 4 and 5. More specifically, the neutral point binding pin 18 is caused to protrude from the outer periphery of one of the first, second and third tees 3 from the left end of the straight core 16.

(2-4) Winding Steps

Description will now be made of the winding steps for putting the three phase windings 8 about the straight core 16 having 12 slots.

A nozzle 9 having a winding 8 passed therethrough is moved around each tee body 3a of the stator core 7 to have the winding 8 wound about the tee body 3a, as shown in Fig. 3. The winding is carried out on the tees 3, juxtaposed in parallel to one another.

As the stator 10 has twelve (12) tees 3, three nozzles 9 are juxtaposed so as to correspond to three tees 3, respectively, and carry out winding ~~about~~ around them simultaneously. After their winding, the nozzles are moved to other slots and such winding is repeated four times, whereby winding is carried out in all of the 12 slots. The winding for the U phase is carried out in the first, fourth, seventh and tenth slots from the left end of the straight core 16, the winding for the V phase in the second, fifth, eighth and eleventh slots, and the winding for the W phase in the third, sixth, ninth and twelfth slots.

Thus, it is possible to finish a winding job at a high speed and select the number of turns of winding as desired, as compared with the winding for an annular stator core. The windings 8 put about the tees 3 juxtaposed in parallel to one another achieve an improved ratio of occupation in each slot 6. When the tees 3 are juxtaposed in parallel to one another, the distance between either end of the converging portion 3b of one tee 3 and the adjacent end of the converging portion 3b of each adjoining tee 3 or the width of each opening 11 and the area of each slot 6 are greater than the width of each opening 11 and the area of each slot 6, which occur after the back yokes 2 are bent, as will hereinafter be described. Moreover, it is possible to put the winding 8 around without considering the space for the rotation of the nozzle 9 and thereby achieve an improved ratio of occupation over what has hitherto been possible. Moreover, as the stator core 7 having twelve (12) tees 3 does not have a large number of slots, it allows an efficient winding job and makes a motor having a good balance between its fabrication efficiency and characteristics.

(2-5) Steps for Connecting Wiring

Description will now be made of the steps for connecting wiring between the winding 8 for each phase and the winding 8 for the neutral point. A star connection of the three phases ~~will be~~ is made.

The U-phase winding 8 is bound with the U-phase binding pin 17 at one end

and with the neutral point binding pin 18 at the other end. The V-phase winding 8 is bound with the V-phase binding pin 17 at one end and with the neutral point binding pin 18 at the other end. The W-phase winding 8 is bound with the W-phase binding pin 17 at one end and with the neutral point binding pin 18 at the other end.

The wiring for connecting the winding 8 for each phase to the neutral point binding pin 18 is made as shown in Fig. 5. More specifically, the other end of the U-phase winding 8, put around the tee 3 for the U phase, is drawn to the top of the tee 3, then to the outer periphery of the upper covering 14 through its upper slot 14a and then to the neutral point binding pin 18 along the outer periphery of the upper covering 14, and is fastened to the neutral point binding pin 18. The same is repeated for the windings 8 for the other two phases.

The wiring for connecting the winding 8 for each phase to the binding pin 17 for each phase is made as shown in Fig. 5. More specifically, one end of the U-phase winding 8, put around the tee 3 for the U phase, is drawn to the bottom of the tee 3, then to the outer periphery of the lower covering 20 through its lower slot 20u and then to the U-phase binding pin 17 along the outer periphery of the lower covering 20, and is fastened to the U-phase binding pin 17. The same is repeated for the windings 8 for the other two phases. The lower slot 20u for the U phase, the lower slot 20v for the V phase and the lower slot 20w for the W phase

have a greater depth in their order, so that the windings 8 for the three phases may lie in parallel to one another along the outer periphery of the lower covering 20 and not contact one another.

(2-6) Steps for Bending the Straight Core 16

The steps for bending the straight core 16 will now be described.

During the first step, the straight core 16, having the windings put thereon, is bent at each cut 4 so that the tees 3 may be radially directed, as shown in Figs. 6 and 7.

During the second step, the back yokes 2 are bent into an annular shape.

During the third step, the opposite ends of the back yokes 2 are joined to each other by welding or with an adhesive. As a result, the inner rotor type stator 10 is formed.

The cuts 4 have a cut angle which allows the opposite slanting surfaces of each cut 4 to contact each other when the back yokes 2 are formed into an annular shape. An insulator 13 is inserted between the winding 8, put around one tee 3 and the winding 8, put around any adjoining tee 3, in the event that they are likely to contact each other.

(2-7) Steps for Mounting the Wiring Circuit Board 51

The steps for mounting the wiring circuit board 51 will now be described.

The wiring circuit board 51 is disk-shaped and has a bushing 25 attached

to its outer periphery. The bushing is made from a synthetic resin and is used for guiding a plurality of cords 26 from the wiring circuit board 51 to outside the motor 50.

The disk-shaped wiring circuit board 51 is placed on the upper supports 15 of the stator 10 as shown in Fig. 8. The wiring circuit board 51 has four cut-off portions 23 made on its outer periphery and the four positioning projections 19 are fitted on the four cut-off portions 23, respectively, to position the wiring circuit board 51 relative to the stator 10. The four upper supports 15 formed on the fourth, sixth, tenth and twelfth tees 3 from the left end of the straight core 16 are arranged in a diametrically opposite relation, as shown in Fig. 8, to provide a stable mount for the wiring circuit board 51, while the positioning projections 19 ensure the coaxial positioning of the wiring circuit board 51 with the stator 10. Moreover, the four positioning projections 19 situated in a diametrically opposite relation hold the wiring circuit board 51 against being pushed out by [[a]] molding resin during molding as will be described below.

The wiring circuit board 51 has wiring patterns 24 and four connecting holes made for receiving the binding pins 17 for the three phases and the binding pin 18 for the neutral point, respectively. When the wiring circuit board 51 is placed on the stator 10, as explained above, the binding pins 17 for the three phases and the binding pin 18 for the neutral point are inserted through the four connecting

holes, respectively, and are soldered to the wiring patterns. As a result, the windings 8 for the three phases and the winding 8 for the neutral point ~~can be~~ are easily connected to the wiring circuit board 51 ~~easily~~.

(2-8) Steps for Making the Motor Frame 53

The motor frame 53 will now be described. ~~In the event that~~ For the case where the stator 10, holding the wiring circuit board 51, as described above, is fitted in a traditional motor frame made of a steel plate to assemble a motor, the axis of the stator core 7, based on its inside diameter, does not coincide with its axis based on its outside diameter, since the outside diameter of the stator 10 is not ~~of~~ a true circle. It is, therefore, difficult to assemble a motor by relying upon the outer periphery of the stator 10. A reduction in the mounting accuracy of rotary bearings, ~~etc.~~ and the like, on a motor frame made of a steel plate, gives a product of low performance.

According to the first embodiment of this invention, therefore, the motor frame 53 is formed by molding from an insulating resin, or premix (hereinafter called the molding resin) by employing the inside diameter of the stator 10 as a standard for molding. More specifically, the inside diametrical portion of the stator 10, holding the wiring circuit board 51, as described above, is fitted ~~about~~ around a core in a resin mold (not shown), and after the mold is closed, the molding resin is supplied at a high pressure into the mold. As a result, the stator core 7, wiring

circuit board 51, ~~etc.~~ and related elements are integrally covered with the molding resin 52 to give a molded motor frame 53.

As the housing for holding the bearing 55 for supporting the rotor 56 and the socket portion 59 for holding the bracket 54 are formed at the same time by employing the inside diameter of the stator core 7 as a standard for molding, the axis of the stator core 7, based on its inside diameter, the axis of the housing, and the axis of the socket portion 59, coincide with one another to give a motor of high accuracy having a uniform air gap. The bearing housing is coaxial with the stator 10, as it can be formed integrally with the motor frame 53 by employing the inside diameter of the stator 10 as a standard. The socket portion 59 with which the bracket 54 engages is also coaxial with the stator 10, as it is also formed with the motor frame 53. Thus, the motor frame 53 ensures a high accuracy of assembly.

(Second Embodiment)

A second embodiment of the invention, relating to the joined ends of the back yokes 2 of the stator 10, will now be described with reference to Figs. 9 and 10.

In the event that the joined ends of the back yokes 2 are flat and are welded only at their outer periphery ~~alone~~ , as according to the first embodiment of the invention, the back yokes in the vicinity of their joined ends are likely to resonate with a diametrically occurring electromagnetic vibration and cause undulation about

the welded joint. This problem is overcome by crank-shaped joined ends 44 according to the second embodiment of the invention.

Fig. 9 is an enlarged front elevational view of the joined ends 44 of a back yoke 2 according to the embodiment under description and their vicinity, and Fig. 10 is an enlarged front elevational view of the joined ends 44 of the back yoke 2 having a gap formed therebetween and their vicinity.

A stator 10 is made by bending a straight core 16 into an annular shape, as stated with reference to the first embodiment. The opposite ends 44 of the back yokes 2 in the straight core 16 are crank-shaped, as viewed from the axis of rotation. The back yokes 2 have projections 45a and 45b on their outer periphery at their opposite ends, respectively. The back yokes 2 are bent to have their projections 45a and 45b engage each other, and a laser 46 is brought close to the projections 45a and 45b for welding them together.

The structure as described ensures that even if any gap ~~may be~~ is formed between the joined ends 44 of the back yokes 2, as shown in Fig. 10, bent surfaces 44a, formed midway between the joined ends 44, form a wall preventing a laser beam from reaching the inside of the back yokes 2 and damaging the windings 8. Even if ~~some~~ a gap ~~or other may be~~ is formed between the joined ends 44 of the back yokes 2, the bent surfaces 44a of the joined ends 44 remain joined to each other, so that a magnetic path ~~may be~~ is maintained, as shown by an arrow in Fig.

10, to ensure a good flow of [[a]] magnetic flux.

Moreover, the crank-shaped joined ends 44 ~~mean~~ advantageously necessitate that the back yokes 2 are joined at two points, i.e. the welded joint (projections 45a and 45b) and the bent surfaces 44a of the joined ends 44. As a result, the joined ends 44 are extremely rigid so ~~high in rigidity~~ as not to readily undergo resonance ~~easily~~. The stator 10 is improved in its strength against a molding pressure prevailing in the event of the molding of the motor frame from a molding resin, and does not easily get separated at the joined ends 44.

The joined ends 44 of the stator 10 may alternatively be formed by adhesion.

ABSTRACT OF THE DISCLOSURE

~~In a~~ A molded motor ~~having~~ has a motor frame molded by covering a stator ~~composed by~~ made from a straight core, with a molding resin[[,]]. [[the]]The straight core has a stack of laminas each having a plurality of tees projecting from one long side of a belt-shaped back yoke and a V-shaped cut formed between every two adjoining tees along the back yoke and on [[its]] a side from which the tees project. The straight core has an insulating layer thereon, formed by pre-molding from an insulating resin, ~~on its portions~~ excluding at least [[the]] an inner periphery of each tee. The straight core also has a winding formed about each tee having the insulating layer formed thereon. The stator is formed by bending the straight core at [[the]] cuts made therein into an arcuate or annular shape, and joining the opposite ends of the back yokes to each other by welding or adhesion.